Space Weather Technical Forecast

Issued on Wednesday, 09 February 2022 at 01:22 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Likelihood of G1/Minor Storm activity on day 1 (09 February) and a chance on day 2 (10 February), associated with CME arrival. Active electron fluence expected days 1 and 2 (09 February). Chance of M-class flares.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been low over the last 24 hours, with occasional C-class flares. The most energetic of these was a C5.1 from 2939 (Cho/Beta), a large mature region in the southwest quadrant. Two regions in the northern hemisphere, 2941 (Fai/Beta) and 2940 (Dai/Beta) are both large, carry a significant flare risk and continue to evolve. 2943 in the southeast, is new, small and benign. No Earth directed CMEs have been observed in available imagery.

Solar Wind / Geomagnetic Activity: The solar wind at L1 has declined through the last 24 hours from 450km/s to 400km/s, but with a brief spike to 470km/s at the end of the period. Density was below average throughout. Interplanetary magnetic field strength has been weak, with the north-south component, Bz, also varying weakly. Phi angle was predominantly negative (towards the Sun). Geomagnetic activity was Quiet.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) measured at GOES 16 was at background levels. The high energy electron flux (greater than 2MeV) has been above the high threshold throughout, peaking at 1.14e4pfu at 08/1535UTC. Electron fluence values are above the Active (1e8 integrated pfu) threshold on a rising trend, reaching 5.59e8 integrated pfu at 09/0000UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is expected to remain low through the next four days, with a chance of isolated M-class flaring due to the three large active regions on the solar disc.

Solar Wind / Geomagnetic Activity: A CME which left the Sun on 06 February is forecast to arrive at the Earth on 09 February with an estimated speed of 800km/s. The CME may then perturb the geomagnetic environment around the Earth over the following two days. The high speed stream from coronal hole 53 is expected to connect with the Earth late on day 4 (12 February). Geomagnetic activity is expected to start Quiet to Unsettled, with Active periods expected and a likelihood of G1/Minor Storms or G2/Moderate storms due to the CME arrival. Residual and decreasing effects of the CME are then possible through days 2 and 3 (10 and 11 February). The onset of the high speed stream from coronal hole 53 may then produce further G1/Minor Storms.

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Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is forecast to be at background levels, but with a slight chance of rising close to, or just above, the S1 level given any significant flares. High energy electron flux is likely to fall below the high (1e3pfu) level on day 1 (09 February) due to the effects of the CME arrival. Any recovery is then uncertain and dependent on the persistence of any post-CME activity which could suppress electron counts in the radiation belts. Active (1e8 integrated pfu) electron fluence levels are expected on day 1 (09 February) with a decline then likely by day 2. Any recovery is subject to the behaviour of the electron flux following the CME.

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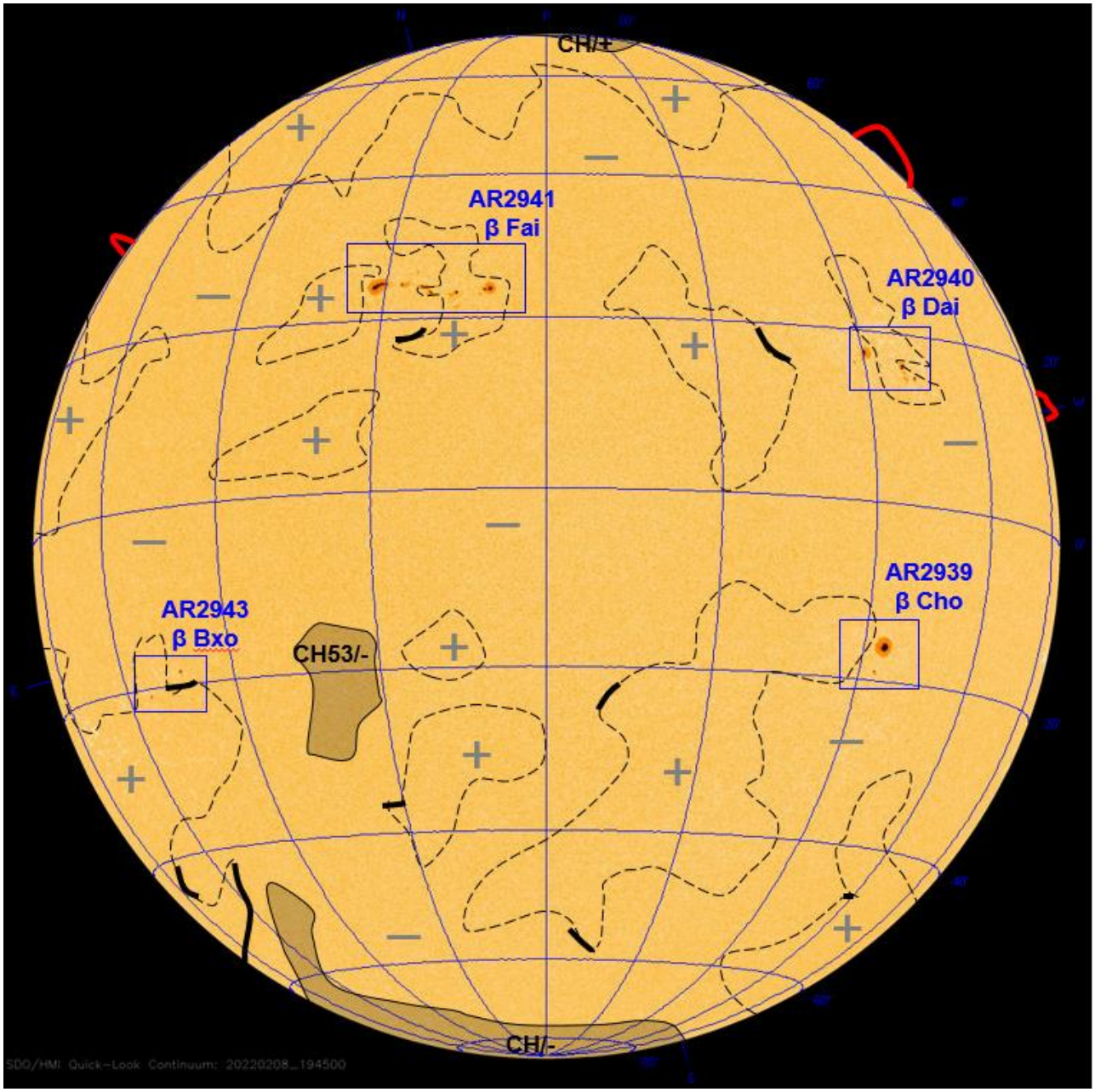
Figure 1. Solar Analysis Valid 09/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME which left the Sun 06 February is forecast to arrive at Earth on 09 February. The filament eruption which gave rise to the CME erupted from centre disc in the region of AR2939, but the resultant halo had a slight southeastward bias, so there is some uncertainty in the level of impact at Earth. Enlil is suggesting that the main portion of the feature may pass close to the east of the Earth, but a significant portion of the CME is still expected to directly affect Earth. The most likely arrival time is around 09/1200UTC, with the MOSWOC Enlil ensemble suggesting a range of 6 hours either side of this.

Any lingering coronal hole effects are expected to have wane by 09 February. The next coronal hole high speed stream, from coronal hole 53, may arrive late on day 4 (12 February), with peak speeds of 600-700km/s possible, based on persistence from this recurrent feature.

Geomagnetic activity is expected to start Quiet to Unsettled, with Active periods expected and a likelihood of G1/Minor Storms or G2/Moderate storms due to the CME arrival. Residual effects of the CME are then possible through days 2 and 3, which are dependent on the post-shock magnetic sheath. The onset of the equivalent high speed stream from coronal hole 53 generated G1/Minor Storms on the last rotation, with a similar effect possible, especially in a primed post-CME environment.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	60	40	10	20
Strong	G3	No	10	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
07/0003	Partial	Filament eruption near 2939	Centre disc	400	09/1000 UTC	G1/Minor storms likely

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Figure 2: MOSWOC Enlil, showing forecast arrival of CME around 09/1000UTC

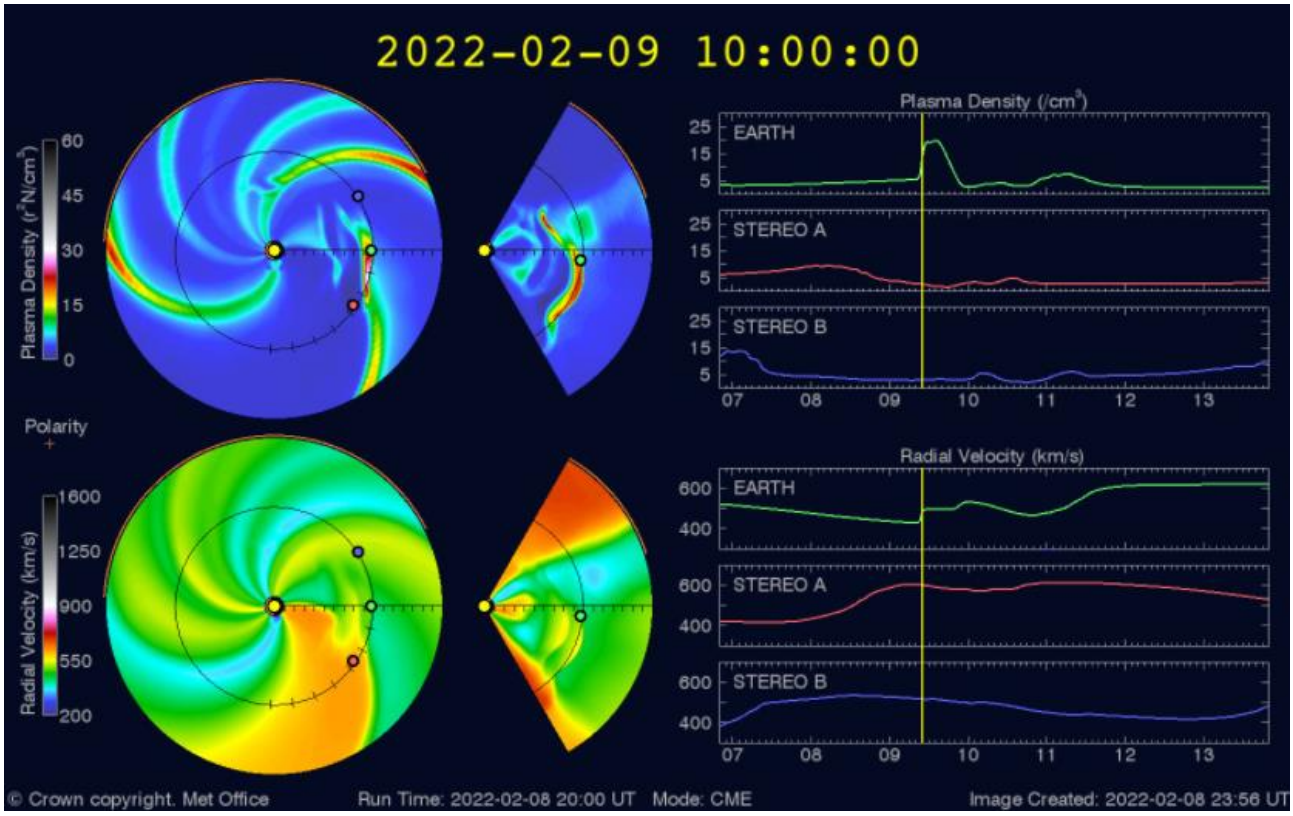
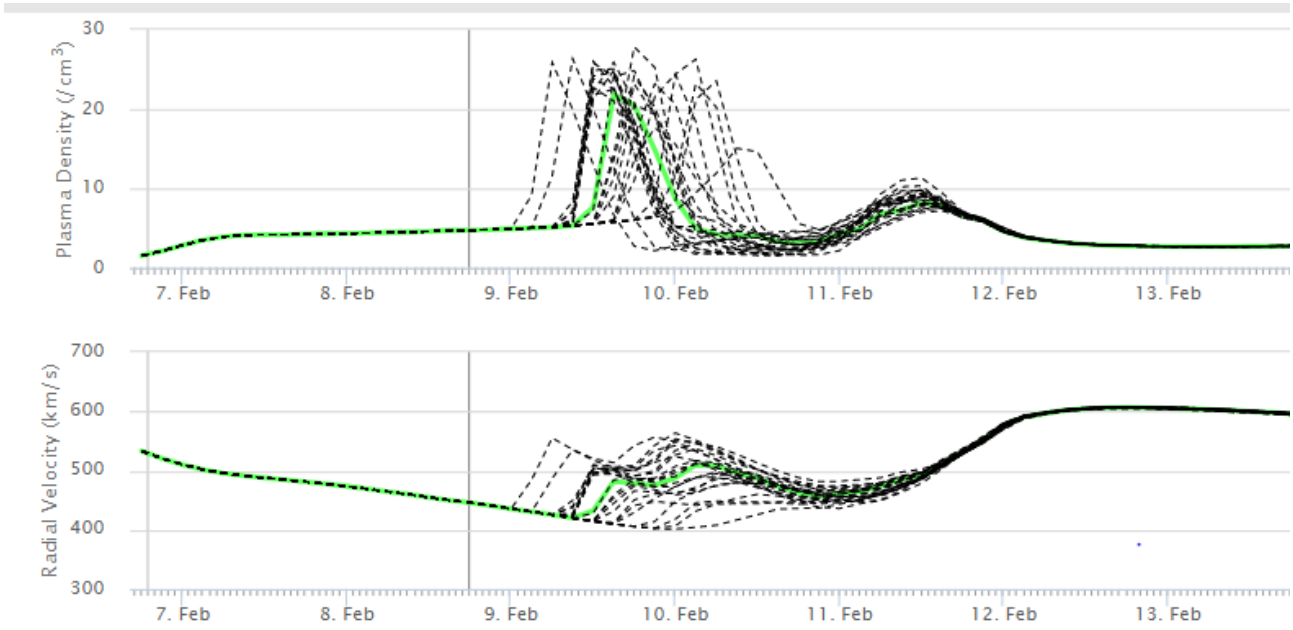


Figure 3: MOSWOC Enlil ensemble, showing range of potential arrival times.



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Radio Blackouts - X-Ray Flares:
There are four sunspot regions on the visible disc, with three of the larger regions, 2939, 2940 and 2941 all passing through periods of development, with subsequent subdued periods. 2941 is the largest region and has lengthened to be classified as Fai/Beta, with several intermediate spots developing. 2940 (Dai/Beta) seems to be relatively stable with the looping appearing uniform. 2939 (Cho/Beta), from where the 06 February CME emanated, has recently produced a C5.1 flare, indicating a risk of further X-ray flares. 2943 is new and currently benign.

Solar activity is expected to be mainly low, with a persistent background of C-class flaring. Based on the position and history of the three largest regions, there is a chance of M-class flares through the next 4 days.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	30	30	30	30
Very Active	R3 to R5 X Class	No	2	2	2	2

Figure 4: GOES-16 X-ray flux

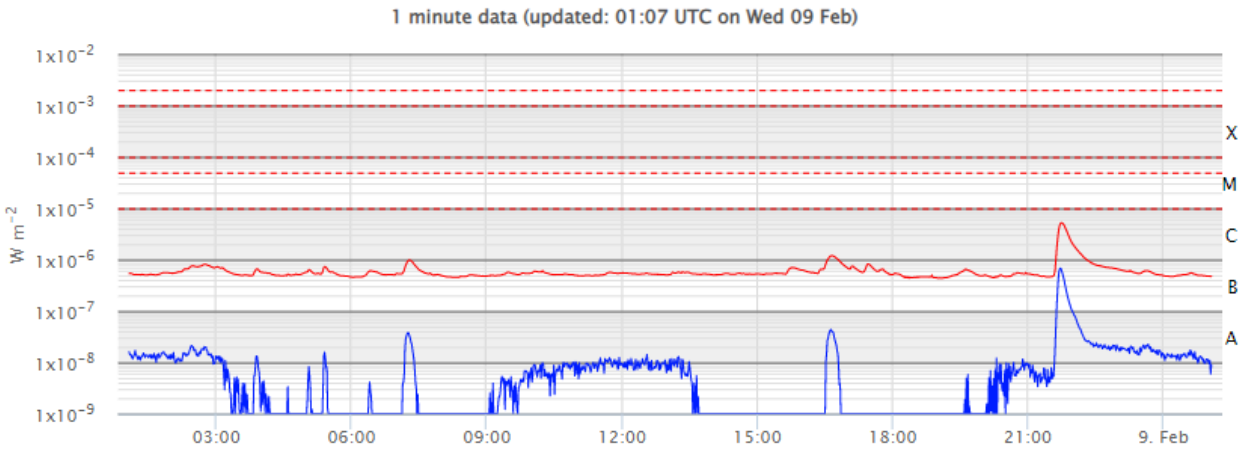

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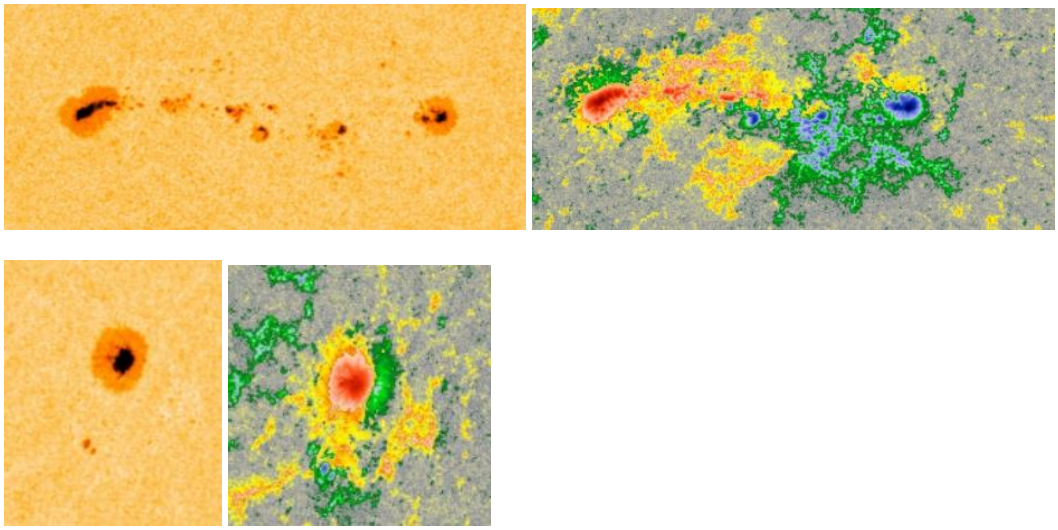
Figure 5: SDO HMI intensitygram and magnetogram imagery for AR2941 (Fai/Beta) (top) and AR2939 (Cho/Beta) (bottom), the two most active regions on the visible disc.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux, as measured by GOES-16 is at background levels. Solar radiation storms are not expected in the period. However, there is a very slight chance for proton fluxes to rise given any significant flaring from AR2939 and AR2940, as they continue to transit across the western hemisphere.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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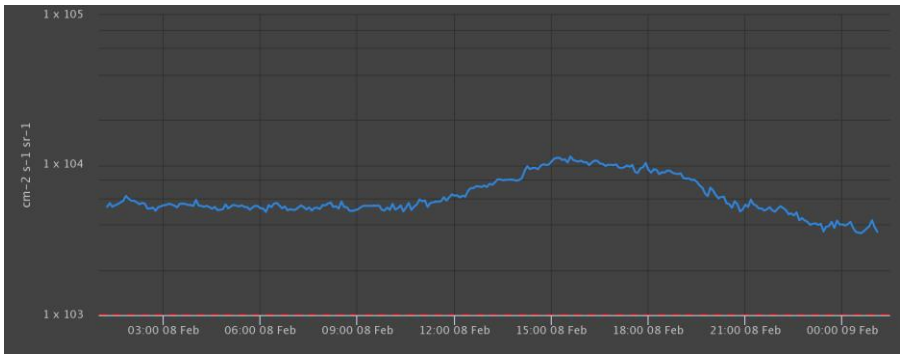
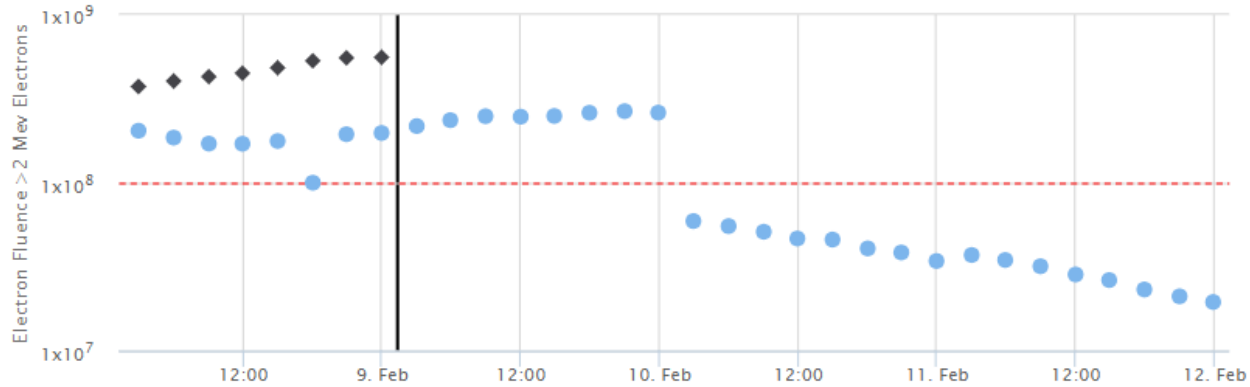
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) is expected to start at high (1e3pfu) levels on day 1 (09 February), but is then likely to fall sharply due to the geomagnetic activity from the forecast CME arrival. The speed of the CME, around 800km/s could also distort the radiation belts away from GEO. Following the CME arrival confidence in the behaviour of the electron flux decreases, as this depends on the extent of the post CME shock and how quickly the radiation belts may return to an unperturbed state.

24-hour fluence values are expected to remain above the Active (1e8 integrated pfu) threshold through day 1, but then decline as the electron flux decreases from day 2 (10 February). The probabilities represent the uncertainty in the level of decline and then the speed of any recovery.

GEO Electron Environment	Level ($cm^{-2}\ sr^{-1}\ day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	Yes	100	50	40	40
Very Active	≥ 2 MeV ≥ $1x10^9$	No	5	5	1	1

Figure 6: GOES 16 electron flux and MOSWOC REFM fluence observations. The electron fluence values are expected to decline from day 2 onwards.





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